



Students' Engagement and Information-Seeking Behavior During a High School-Matching Process

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**Students' Engagement and Information-Seeking Behavior
During A High School-Matching Process**

Qualifying Paper

Submitted By

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July 2015

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Students' Engagement and Information-Seeking Behavior During A High School-Matching Process

America's rising inequality in educational opportunities, by income, not only takes place across its public-school districts, it also takes place within them. In many of the nation's large urban school districts, high-quality schools are often located in high-income neighborhoods and low-quality schools are located in low-income neighborhoods (Duncan and Murnane, 2011).

Many argue that districts' traditional public-school assignment processes exacerbate and institutionalize these unequal educational opportunities by setting students' default schooling option as their neighborhood high school. Such assignment processes allow middle-class families who are seeking high-quality public-school options for their children to "vote with their feet" and live in high-rent areas of the district, while low-income families can only live in low-rent areas (Hirschman, 1970). The resulting concentration of social and economic capital in high-rent areas acts to enhance the neighborhood's school quality through a few mechanisms: families use their social capital to demand and acquire additional amenities for their schools; families have the economic resources to supplement their child's daily school curriculum with additional after-school and summer activities (Reardon, 2011); and, because they will pay the same amount but offer a more heavily-resourced environment, these schools attract a greater proportion of the high-quality public-school teachers within the district (Loeb, S., & Reininger, M., 2004, Darling-Hammond and Post, 2000).

Recently, many districts have attempted to decrease these neighborhood-based inequalities by implementing centralized intra-district school-choice processes. While

their specific designs may differ, districts hope that by creating a central, institutionalized process for pairing students with schools based on students' and parents' schooling preferences rather than their residential location, they will be able to give all families within their district the opportunity to select the high-quality school option that is best for their child (Abdulkadiroglu, Pathak, Roth & Sonmez, 2006).

While intra-district school-choice systems may enhance the schooling options available to many families, they also raise potentially important equity concerns. If the processes for applying to high-quality schools are either overly complicated or vague, they may still privilege the elite who have bureaucratic connections and experience navigating similar systems (Abdulkadiroglu, Pathak, Roth & Sonmez, 2006). In addition, if information on school quality is difficult to attain or understand, they may privilege wealthier families and/or parents with higher education levels who have a lower cost to attaining and assimilating such information (Hastings and Weinstein, 2008). Finally, underlying such systems is the question – should all students and parents have the same definition of “school quality” and rank schools similarly, or by investigating a students' schooling options can families find a unique, “best match” school for their student?

In this paper, I use one large district's implementation of a district-wide high-school assignment process designed to increase all students' school options to investigate families' engagement with the school-choice process and whether this engagement increases students' subsequent academic attainment. I do so by focusing on a specific set of high schools in the district that incentivized students to make contact with them during the high-school selection process by offering an admissions priority to students who made contact. Within this context I investigate whether students with particular

characteristics, such as high family-income levels or high eighth-grade test scores, were more likely to make contact with and acquire information about their high-school selections than students with low family-income levels or low eighth-grade test scores. Next, I investigate whether making contact increases students' probability of future academic success by attempting to identify a casual relationship between making contact and a decreased probability of students dropping out of school and/or an increased probability of students graduating high school in four years. In these analyses, I control for the measurable student characteristics that predict whether a student will make contact (detected in the earlier analysis), in an attempt remove any observed selection bias from my identification of the relationship between making contact and students' on-time high school graduation.

In the remainder of this paper, I describe the economic theory behind intra-district school-choice processes and place my work in the context of the existing empirical evidence on families' behavior during school-choice processes; I describe my site, student sample and analytic approach; I present my findings; I discuss threats to the validity of my findings; and I conclude with a discussion of their implications and potential next steps for the field.

Background and Context

In the past two decades, an increasing number of urban districts have adopted intra-district school-choice systems in effort to increase their overall level of educational quality and reduce disparities in educational opportunity, by income. In an effort to bring attention to this movement in 2010 the Brown Center on Education Policy at Brookings

began ranking school-district choice systems by their available school options and processes for matching students to schools. In their annual reports, the Center has found that, to date, 106 districts that have implemented such systems. Additionally, every year since 2010 at least one large urban district has adopted an intra-district choice process (Whitehurst, 2014).

One early adopter of intra-district school-choice processes, Charlotte-Mecklenburg, instituted a process in 2002 and has been the site of most research on family's behaviors during such processes. Specifically, in studying the introduction of the process, Deming and his colleagues (2014) found that when offered the option, students from low-income homes in that district did indeed choose a higher-quality (as measured by a combination of student, teacher and postsecondary performance statistics) school over their neighborhood high school.

Other research conducted in Charlotte-Mecklenburg points to the importance of accessing information on school quality during the school-selection process. Specifically, when Hastings and Weinstein (2008) distributed easy-to-comprehend statistics on schools' state-standardized test performance to randomly selected low-income families, families that received the additional information had a higher probability of choosing schools with high-scoring student bodies for their children than families that only had access to the complex publicly available data. Follow-up research by Hastings and her colleagues (2009) examining heterogeneity in choice behavior among families in the district found that when students' families reported placing a heavy weight on a school's academic achievement data, after going to their preferred school the students experienced

test score gains, whereas students from families that did not place a heavy weight on the school's academic achievement record did not.

Hastings' research suggests that increasing the information available to students prior to the choice process caused them to choose higher-performing schools and that for those that reported using the information to make their choices, it also improved their future academic performance. It does not address which families would seek out this information if they knew it existed and could easily be made available to them. In addition, it is unknown whether all students would do better by going to these schools, or if there is an additional component of this process – the quality of the student-school “match”.

There is little research on the quality of student-school matches within school-choice processes, but some of those observing and working within school-choice systems believe that requiring students to connect with schools before making decisions (rather than just going off of published school-performance statistics) is essential for both parties. They argue that the connection allows schools to communicate their academic focus and behavior expectations to families before the match has already been made and it allows students to determine if they will be successful academically within such an environment. Specifically, in 2005, the director of one district's school-choice process stated that “not all schools are the right fit for all students” and that school-choice systems must have built-in mechanisms for encouraging schools and families to communicate with each other prior to the selection process. Unfortunately, parents from the same district reported that it is often hard to navigate the process and difficult to find

information on whether schools offer programs for at-risk students, English-language learners or students with special needs (Hemphill and Nauer, 2009).

Although compelling, the argument that providing school choice may increase *all* students' academic achievement warrants more research. In her paper, "When Can Public Policymakers Rely on Private Markets? The Effective Provision of Social Services," Rebecca Blank (2000) highlights the dangers of leaving the provision of social services to competitive markets like school-choice processes. Blank suggests that there are high probabilities of the process failing because of different levels of information accessed by participants. In particular, she argues that when the quality of the service provided is difficult to observe (as it is when trying to discern school quality and the appropriate student-school match), it is very difficult for participants to choose the best option and so the fairness promised by the market structure breaks down (Blank, 2000).

If the market structure underlying school-choice processes break down it can lead to unexpected and unintended consequences for school districts implementing intra-district choice systems. For example, when school quality is difficult for students and parents to observe, and if information on school quality is more available to some families than to others, the intra-district school-choice process may advantage one set of parents and students over another unintentionally. In the worst case, if high-income or high-achieving students and their families are able to access information on school performance more easily than others in the district and make informed decisions regarding where they will be most successful, either because of their higher-education levels or connections with other informed families, a district-wide school-choice process may contribute to the sorting of high-income and high-achieving students into the

highest-performing schools and the neediest student populations into the lowest-performing schools.

Conclusion: Specific Research Questions

In this paper I investigate these issues by conducting a case study in which I examine eighth-graders' engagement and information-gathering behavior during an intra-district school-choice process in the nation's largest urban district – the New York City school district. I focus on the 2004 implementation of an intra-district school-choice process for all 70,000 eighth-graders in New York City public schools and a set of over 100 small schools specifically created during this time period to promote student engagement and information-seeking behavior during the high school choice process. As I describe in *Appendix A*, the new intra-district school-choice system required all eighth-graders to create a “choice list” of up to 12 high schools; allowed high schools to rank students based on their predetermined selectivity criteria; and matched students to schools based on a complex algorithm developed to optimize student-school pairings (Quint, Smith, Unterman and Moedano, 2010). As I describe in *Appendix B*, this set of over 100 newly-created small high schools were unique within the district, in that while they were small and focused on promoting an academically rigorous curriculum, they did *not* screen students based on their prior academic performance (unlike other similarly-sized schools). For this reason researchers refer to these schools as NYC's “small schools of choice” (SSCs) (Bloom and Unterman, 2014).

SSC's unique student-screening preference is particularly relevant to the focus of this paper. Rather than screening students academically, SSCs gave priority to students who had made explicit contact with them during their eighth-grade school year *either* by

attending either a school open-house *or* by visiting their booth at a district-sponsored high-school fair (Bloom, Thompson and Unterman, 2010). Using data collected by the high school choice process administrators during its 2004 implementation, I investigate whether -- among students who included at least one SSC in their choice list -- students with particular characteristics, such as those with high family-income levels or high eighth-grade test scores, were more likely to make contact with and acquire information about their high-school selections than students with low family-income levels or low eighth-grade test scores. Thus, I first address the following research question:

1. Do students with particular characteristics have a higher probability of making contact with at least one school on their choice list than other students? In particular, do higher-income and higher-academically achieving students have higher probabilities than other students of making contact?

Then, in follow-up analyses, I investigate the casual relationship between whether a student choosing to make contact with at least one of the schools on their choice list in eighth-grade increases the probability of their future academic success. Specifically, I address the follow research questions:

2. Does making contact with at least one school on a student's choice list increase a student's probability of graduating high school in four years? Does it decrease their probability of dropping out of high school?

Notice that, in addressing my first question, I treat contact as an outcome: did a student contact at least one school on their choice list or not, during eighth grade. In my second set of analyses, on the other hand, I treat the same variable -- contact -- subsequently as an exogenous question predictor and attempt to identify whether making

contact with a school on their choice list *causes* students to have a higher probability of graduating high school in four years. Unfortunately, the variable is unlikely to be exogenous in these analyses as it is a consequence of a choice process in which the student has engaged. Thus, it is possible that any detected relationship between contact and ultimate high-school graduation is a consequence of important omitted explanations that drive both contact and graduation. To better estimate the relationship between contact and four-year high school graduation, I apply what I learned in answering my first research question about the selection process that drives contact to reduce or eliminate the potential selection bias. Specifically, in analyses to address my second research question, I control for the observed predictors of contact in an effort to remove observed bias introduced by the potential endogeneity of contact. In this approach I borrow from the analytic framework often used in propensity-score matching approaches (Murnane and Willett, 2011) as well as the extensive literature on estimating returns to an additional year of education using Ordinary Least Squares regression techniques. I discuss potential problems with this approach in the *Threats to Validity* section that follows my findings.

Research Design

Dataset

To address my research questions, I have analyzed a dataset from the New York City High-School Application-Processing System (HSAPS). It contains the high-school preferences of all eighth graders who attended NYC public schools and participated in the main round of the 2004-2005 high-school application process. To follow these

students from first contact through high school, I linked these HSAPS data to NYC DOE school records that contain data on students' high-school enrollment and New York State high-school diploma attainment. In *Appendix C*, I describe each data source that contributed to my final dataset and I list the specific steps that made up my dataset-merging process.

Sample

Of the 70,825 NYC public-school eighth-graders in 2004-2005¹, nine percent (6,333) selected a small school of choice as their most-preferred school and 38 percent (26,813) selected a SSC as at least one of their twelve high-school choices. In order to focus my analysis on the contact preference exerted by SSCs, I conducted analyses in the latter self-selected sample of 26,813 students who included at least one SSC among their list of twelve potential high-school choices. This self-selection of participants into the analytic sample, by virtue of choices made during district's eighth-grade high-school selection process, limits the generalizability of my findings to a population of similar self-selected students. I discuss this issue of external validity in greater detail in the *Threats to Validity* section that follows the presentation of my findings.

Of the 26,813 students in my analytic sample, the majority listed at least two SSCs on their school-choice list (41 percent listed one SSC, 25 percent listed two SSCs, 15 percent listed three SSCs, 10 percent listed four SSCs and the remaining nine percent listed five or more SSCs). The selected SSCs were distributed relatively evenly across students' choice lists.

¹ Though students from private and parochial schools in NY can participate in the high school application process I do not include non-NYC public school eighth-graders in my analysis.

Overall, students in the analytic sample were from low-income families and exhibited at least one indicator of having struggled academically in 8th grade. Specifically, 81 percent of the students qualified for free-/reduced-price lunch; 67 percent scored below proficient on their eighth-grade state-administered English Language Arts examination; and 69 percent scored below proficient on their eighth-grade state-administered Mathematics examination. In addition, 22 percent of the students were overage for eighth-grade, suggesting that these students may have been retained in grade at least once in elementary and middle school. In terms of other demographic characteristics (as defined by NYC DOE school records), 49 percent of the students were male; approximately 44 percent were Black, 47 percent were Hispanic, five percent were White and three percent were Asian. Eight percent of the students were English-language learners and 16 percent qualified for special-education services.

Measures

I obtained the New York City High School Application Processing System (NYC HSAPS) data as a student-level (multivariate-choice) dataset, to which each student contributed a single row, their high-school choices being described by the values of twelve variables named choice1 through choice12. I created the following set of measures from the dataset to address my first research question:

- Outcome *Contact* is a dichotomous indicator of whether or not a student made contact with at least one SSC on their choice list (=1; 0 otherwise).
- In addressing this question, I hypothesized that selected theoretically-supported family, personal, and prior academic characteristics of students distinguished those

who chose to make contact with an SSC from those who did not. Based on my review of the literature, I include the following characteristics:

- Question predictor *FRLunch* is a dichotomous indicator of whether a student qualified for free-/reduced-price lunch based on their family's income level in eighth-grade (=1; 0 otherwise).
- Question predictor *PriorM* is a continuous variable that records a student's eighth-grade mathematics score on the state-administered norm-referenced test. Scores ranged from a lowest obtainable scaled score of 517 to a highest obtainable scaled score of 882. The sample mean was 718 with a standard deviation of 40.78. According to the test-makers CTB/McGraw Hill (2005b), the eighth-grade mathematics exam is internally consistent and highly reliable (Feldt-Raju reliability estimate= 0.94). To facilitate my interpretation of the model's parameter estimates I have standardized this question predictor on the sample mean and standard deviation.
- Question predictor *PriorR* is a continuous variable that records a student's eighth-grade English-Language Arts (ELA) score on the state-administered norm-referenced test. Scores on this test range from a lowest obtainable scaled score of 527 to a highest obtainable scaled score of 830. The sample mean was 698 with a standard deviation of 35.98. According to the test-makers CTB/McGraw Hill (2005a), the eighth-grade ELA exam is internally consistent and highly reliable (Feldt-Raju reliability estimate= 0.90). To facilitate my interpretation of the model's parameter estimates I have

standardized this question predictor on the sample mean and standard deviation.

- Question predictor *Absent* is a continuous variable that records the number of times a student was absent from school in eighth-grade. The number of absences in this sample range from zero to 160 with a mean of 16 and a standard deviation of 15. To facilitate my interpretation of the model's parameter estimates I have standardized this question predictor on the sample mean and standard deviation.
- Question predictor *Overage* is a dichotomous indicator describing whether a student had been retained in grade at least once, prior to the eighth-grade, based on whether a student was older than 13 at the start of their eighth-grade school year (=1; 0 otherwise).
- Question predictor *English-language learner (ELL)* is dichotomous indicator of whether the student was identified by their eighth-grade guidance counselor as an ELL student (=1; 0 otherwise).
- Question predictor *Special Education (SPED)* is a dichotomous variable recording whether a student was identified by their eighth-grade guidance counselor as qualifying for special-education services (=1; 0 otherwise).

To address my second research question, in which the former outcome, *contact*, now serves as a question predictor, I merged the NYC HSAPS data with students' 2005-2006, 2006-2007, 2007-2008, 2008-2009 New York City Department of Education (NYC DOE) enrollment and discharge files by each student's unique district identifier. If a

student had graduated², dropped out or moved away during this time period, this was indicated by exit codes on their discharge file.

I created the following set of measures from this dataset (note that some of the variables included in analyses for the second research questions also appeared in analyses to address the first research question):

- Outcome *Graduate4*, created from the NYC DOE discharge file data, is a dichotomous indicator of whether a student graduated from any NYC public high school on time, in four years from entry (=1; 0 otherwise). A student received a value of 1 for *Graduated4* if the NYC DOE discharge files indicated that they graduated high school within the study period. A student received a value of 0 for *Graduated* if their NYC discharge files indicated that they dropped out of high school during the study period or they were still enrolled in the NYC DOE public schools at the end of the study period but had not graduated after four years. Roughly 20 percent of the 8th graders district-wide that participated in the HSAPS process in 2004-2005 did not stay enrolled in NYC DOE public schools through four years of high school and had exit codes on their discharge files indicating that they either moved out of the district or transferred to private/parochial schools, for these students the value of the *Graduate4* is missing. This missingness further limits the generalizability of my findings to those students that stay in New York City Public Schools through four years of high school. I discuss this issue of external validity in greater detail in the *Threats to Validity* section that follows the presentation of my findings.

² In order to graduate from a NYC public high school a student must attain a Local, Regents or Advanced Regents diploma from New York State (NYS), attainment of all diploma types is indicated on students' NYC DOE discharge files.

- Outcome *DROPOUT*, created from the NYC DOE discharge file data, is a dichotomous indicator of whether a student dropped out from any NYC public high school during the study period (=1; 0 otherwise). A student received a value of 1 for *DROPOUT* if the NYC DOE discharge files exit codes indicated that they “dropped out.” In addition, because schools have a strong incentive to code any student that leaves as something other than “dropped out” (as discussed in Murnane 2013), I also gave students with exit codes indicating that they transferred out of the NYC DOE a value of 1 for the variable *DROPOUT*. A student receives a value of 0 otherwise.
- In addressing my second research question, I sought to test whether students who chose to make contact with a SSC prior to the onset of the choice process were more likely to graduate high school (or less likely to drop out of high school) in four years than those that did not.
 - Thus, former outcome, *Contact*, became a critical question predictor in the addressing of the second research questions, and distinguished among those SSC’s that the student did, and did not, contact.
- Acknowledging that the relationship between contact and eventual graduation may have been a consequence of important characteristics of the student that drove both contact and graduation, I removed observed selection bias from my response to the second research questions by controlling for the critical features of the observed selection process that had led to students’ contacting an SSC (which I investigated in addressing the first research question). Thus, explicitly, I included covariates *FRLunch*, *PriorM*, *PriorR*, *ELL*, *SPED*, all of which I had found to be statistically significant predictors of the process.

Analytic Strategy

To address my research questions, I fit the following statistical models, refining them as necessary to remove un-needed predictors and controlling for important covariates, as specified above.

- *RQ1: Do students with particular characteristics have a higher probability of making contact with at least one school on their choice list than other students? In particular, do higher-income and higher-academically achieving students have higher probabilities than other students of making contact?*

To address this question, I fit the following logistic-regression model for student i :

$$\log_e\left(\frac{\text{contact}_i}{1-\text{contact}_i}\right) = B_0 + \beta_1 \text{FRLunch}_i + \beta_2 \text{PriorM}_i + \beta_3 \text{PriorR}_i + \beta_4 \text{Overage}_i + \beta_5 \text{SPED}_i + \beta_6 \text{ELL}_i + \gamma \text{Choice}_i$$

Where parameters β_1 through β_6 summarize the population association between a student characteristics and his/her log-odds of making contact with a school prior to the high-school choice process. When estimates of any of these parameters were statistically significant at the 0.05 level I concluded that there was a relationship, on average in the population, between the given student characteristic and whether or not a student made contact with a school on their choice list. All the statistically significant predictors of the selection process identified in this question then became covariates in my second analytic model.

- *RQ2: Does making contact with at least one school their choice list increase a student's probability of graduating high school in four years? Does it decrease their probability of dropping out of high school?*

To address this question, I fit the following two logistic-regression models:

$$\bullet \quad \log_e \left(\frac{\text{graduation}_i}{1 - \text{graduation}_i} \right) = B_0 + \beta_1 \text{Contact}_i + \beta_2 \text{FRLunch}_i + \beta_3 \text{PriorM}_i + \beta_4 \text{PriorR}_i + \beta_5 \text{Overage}_i + \beta_6 \text{SPED}_i + \beta_7 \text{ELL}_i$$

where parameter β_1 summarizes the population association between a student making contact with a school and his/her log-odds of graduation high school in four years.

$$\bullet \quad \log_e \left(\frac{\text{dropout}_i}{1 - \text{dropout}_i} \right) = B_0 + \beta_1 \text{Contact}_i + \beta_2 \text{FRLunch}_i + \beta_3 \text{PriorM}_i + \beta_4 \text{PriorR}_i + \beta_5 \text{Overage}_i + \beta_6 \text{SPED}_i + \beta_7 \text{ELL}_i$$

where parameter β_1 summarizes the population association between a student making contact with a school and his/her log-odds of dropping out of school in four years.

Notice that, in both models, I have removed observed selection bias by including the descriptors of the observed selection process into the contacting schools that I detected in my response to research question one. When parameter estimate β_1 was statistically significant at the 0.05 level I concluded that there was a relationship, on average in the population, between a student making contact and their probability of graduating high school in four years, adjusting for observed selection bias.

Findings

RQ1: Probability Of Making Contact

In Table 1, I present parameter estimates from logistic regression analyses describing the fitted relationship between the probability that a student will make contact with a school on their choice list (vs. not make contact) and three sets of student characteristics – a characteristic capturing their family's income level (whether they qualify for free-/reduced-price lunch), characteristics capturing their academic performance in eighth-grade (their eighth-grade state standardized Mathematics and

Richard Murnane 3/27/2015 8:58 AM

Comment [1]: I would like to see several models presented and discussed. The first model would be FRLunch without the other covariates. This would tell me whether low-income students are less likely to make contact than higher income students. Then the subsequent models would indicate the extent to which this difference by family income becomes smaller when you control for characteristics of students that are correlated with family income.

English language arts scores and the number of times a student was absent in eighth-grade) and characteristics capturing whether they have any particular educational needs (whether they were overage for grade in eighth-grade, whether they qualify for special-education services and whether they are an English-language learner).

Notice first that students from higher-income families have higher probabilities of making contact with schools on their choice list. Specifically, as presented in Model 1, with no other parameters in the model, on average the fitted odds that a student who does *not* qualify for free-/reduced-price lunch will make contact are 1.26 times the fitted odds that a student who does qualify for free-/reduced-price lunch will do the same (p -value < 0.001). As other student characteristics correlated with family income, such as their academic performance in eighth-grade (Model 2) and specific educational needs (Model 3) are added to the model the strength of this relationship slightly decreases but remains present. Thus, as seen in Model 4, controlling for students' academic performance and specific educational needs, the fitted odds a student who does *not* qualify for free-/reduced-price lunch will make contact are 1.17 times the fitted odds that a student who does qualify for free-/reduced-price lunch will do the same (p -value < 0.001).

In addition, students that are stronger academically, as measured by their eighth-grade state standardized examination scores and eighth-grade absences, have higher probabilities of making contact with schools on their choice list. Controlling for all other characteristics (Model 4), the fitted odds that a student who scored one standard deviation above the mean on their eighth-grade Mathematics examination will make contact are 1.20 times the fitted odds that a student who scored at the mean will do so ($p < 0.001$) and the fitted odds that a student who scored one standard deviation above the mean on

their eighth-grade English language arts examination will make contact are 1.26 times the fitted odds that a student who scored the mean will do so, controlling for all other characteristics ($p < 0.001$).³ Finally, students with fewer absences in eighth-grade are more likely to make contact than those that have many. For example, the fitted odds that a student with 1 absence will make contact are 1.82 times the fitted odds of making that a student with the sample average (16 absences) will make contact.

Finally, controlling for other characteristics, general-education students have higher probabilities of making contact than do two of the academically neediest student subpopulations: students that are overage for grade in eighth-grade (fitted odds = 1.42 p -value < 0.001) and students that qualify for special-education services (fitted odds=1.48 p -value < 0.001). There is not a statistically significant difference in the fitted odds of making contact between general education students and students categorized as English-language learners (fitted odds = 0.90, p = 0.895).

RQ2: Probability Of Academic Success

Students who made contact with a school on their choice list have a higher probability of graduating high school on-time, in four years. In Table 2, I present parameter estimates from logistic regression analyses describing the fitted relationship between the probability that a student will graduate from any high school in the district within four years (vs. not graduate) and whether they made contact with a SSC on their choice list, in eighth-grade. In Model 1, I fit the graduation/contact relationship, including

³ The effects of students' prior reading and math proficiency scores on their probability of making contact do not differ by whether or not they are overage (tests on the requisite interactions lead to p -values of 0.52 and 0.11, respectively).

no covariates. In Model 2, I control for the key predictors of contact identified in question one, where I include the latter to remove observed bias introduced by the potential endogeneity in the predictor contact. In Model 1, antilogging the requisite parameter estimates, without control for observed selection, I find that the fitted odds that a student who made contact will graduate in four years are 2.24 times the fitted odds that a student that did not make contact will do the same (p -value < 0.001). In Model 2, after controlling for observed selection, the magnitude of the fitted relationship between four-year high school graduation and contact decreases in magnitude to 1.34 but remains statistically significant (p -value < 0.001). Thus, even after removing the effect of observed selection, students who make contact still have over one and a quarter times the fitted odds of graduating high school in four years, when compared with similar students who did not make contact.

Students who made contact with a school on their choice list have a lower probability of dropping out of high school during the study period. In Table 3, I present parameter estimates from logistic regression analyses describing the fitted relationship between the probability that a student will drop out of high school within four years (vs. not dropout) and whether they made contact with a SSC on their choice list, in eighth-grade. In Model 1, I fit the graduation/contact relationship, including no covariates. In Model 2, I control for the key predictors of contact identified in question one, where I include the latter to remove observed bias introduced by the potential endogeneity in the predictor contact. In Model 1, antilogging the requisite parameter estimates, without control for observed selection, I find that the fitted odds that a student who made contact will dropout of high school are 0.58 times the fitted odds that a student that did not make

contact will do the same (p -value < 0.001). In Model 2, after controlling for observed selection, the magnitude of the fitted relationship between four-year high school graduation and contact decreases in magnitude to 0.68 but remains statistically significant (p -value < 0.001). Thus, even after removing the effect of observed selection, students who make contact still have a dramatically lower probability of dropping out of school in four years, when compared similar students who did not make contact.

Threats to Validity

Four weaknesses in my research design and data analysis affect all the findings that I present in this paper.

First, as described earlier, of the 70,825 NYC public-school eighth-graders in 2004-2005⁴, only 38 percent (26,813) selected a SSC as at least one of their twelve high-school choices. Because SSCs are the only schools in the district that identify students as having made contact with them, or not, my research sample is therefore limited to these 26,813 students who included at least one SSC on their list of twelve potential high school choices. This means that the sample whose choices I have described in this paper is self-selected, based on students' high school preferences, and my findings cannot be generalized to the broader population of all students or schools participating in a high-school choice process. Rather, they must be limited to the self-selected population of students who would make such choices and the schools that these students chose.⁵

⁴ Though students from private and parochial schools in NY can participate in the high school application process I do not include non-NYC public school eighth-graders in my analysis.

⁵ All of the SSCs in operation during this time period are represented by the analysis sample. In total, of these 110 SSCs (out of 365 public high schools in NYC), ninety of them were attended by both students

Second, the generalizability of my findings is constrained by limitations in the availability of my sample's four-year follow-up data. Specifically, approximately 27 percent of the eighth-graders district-wide who participated in the HSAPS process in 2004-2005 did not remain in NYC public schools through four years of high school. The exit codes on their discharge files indicate that they either moved out of the district or transferred to private/parochial schools. Thus, these students cannot be included in the sample when conducting analyses to address my second set of research questions, as data on their high-school graduation is missing. In Appendix E, in follow-up analyses, I investigate whether it is possible to predict whether there is a relationship between a student having made contact with a SSC on their choice list in eighth-grade and departure from the sample (i.e., missingness on the outcome). Fortunately, I cannot detect one. Regardless, I regard the generalizability of my findings as being limited to those students who remained in the New York City Public Schools for all four years of high school.

Third, whether or not a student made contact with one of these schools through an open house or a school fair cannot be considered a perfect proxy for whether they acquired information on the particular school. The reason is that there are other ways students could have acquired some information about the school. For example, they could have heard about the school through friends or read about it online or in the high-school handout. Alternatively, they could have attended an open house, but learned very little about the school. Thus, I must regard contact as a noisy measure of whether a student acquired information about a school during the selection process and I expect this noise

that did, and did not, make contact with them in advance, and 11 were attended solely by students that did make contact with the school prior to the choice process.

to have attenuated (negatively biased) any relationship that I detected in investigating the relationship between contact and graduation in addressing my second research questions.

Finally, in addressing my second research questions and investigating the relationship between contact with the school and subsequent high-school graduation, I have treated contact – a critical variable that describes student selections – as an exogenous predictor. However, in the transition to high-school, because students *chose* to make contact with a SSC and also *chose* to graduate from the high-school they attended, it may be that – in these analyses – predictor contact is endogenous. My estimate of the relationship between contact and graduation is therefore potentially biased by this selection. I have attempted to ameliorate this bias by determining -- in analyses for my first research question -- descriptors of the process of contact, and then including them subsequently as covariates in analyses to address my second research questions. These latter descriptors of predictors (*FRLunch*, *PriorM*, *PriorR*, *ELL*, *SPED*), in essence, provide me with a model of the selection process that led to contact and their inclusion in the second round of analyses thereby removes the observed bias due to them, from my estimate of the relationship between contact and graduation. If I were able to fully describe – that is, determine all such descriptors -- of the selection process that lead to students making contact and include them in subsequent analyses to address research question two, then my estimates of the relationship between contact and four-year high school graduation would provide an unbiased estimate of the impact of making contact with an SSC on the probability of graduating from high school on time. Unfortunately, this assumption (of unconfoundedness) is a strong assumption and may not be tenable. It is likely that immeasurable characteristics, such as family attitudes towards education and

student motivation, will also push students to both make contact and ultimately graduate from high-school on time. If this is the case, then my estimates of the impact of contact on on-time graduation in the second round of analyses remain biased and my estimate of the effect of contact on four-year high school graduation may appear greater than it is, in reality.

In essence, my estimates of the impact of contact on on-time high school graduation may be plagued by a bias analogous to the infamous “ability bias” plaguing Ordinary Least Squares (OLS) regression estimates of the returns to education. In each case, an immeasurable characteristic may be related to the question predictor and the outcome of interest. In his 1999 review of the literature on the casual effects of education on earnings, Card concludes that the OLS regression estimates of the returns to education are between 10-20 percent higher than estimates from more rigorous research designs. While is not clear whether the potential bias in my approach would be greater than this range, it may be able to serve as a helpful reference point for my estimated effects.

Discussion

In exploring the behavior of students and parents in NYC, I find that among students who included at least one SSC on their high-school choice list, it was those who were better-off economically and higher-performing academically that made contact with schools prior to the HSAPS process. I also find suggestive evidence that, within this group, students that make contact have a markedly higher probability of graduating from high school in four years and a markedly lower probability of dropping out of high school than those who do not make this contact.

My findings suggest that either making contact with at least one school helps a student learn information that informs all their high-school choices, or that the contact students within this sample all share a different, unobservable trait, one that both helps them successfully navigate the eighth-grade high school choice process and stay on-track through high-school. Patillo (2014), has qualitatively studied the introduction of charter schools in Chicago and finds that students who navigate choice systems successfully have families with strong social networks that they can rely on for information about the process and often have a highly-engaged family member providing them with guidance. While a complementary qualitative study would be necessary to come to the same conclusion in this setting, these results support each other.

More work needs to be done to determine how students learn about the school-choice process requirements and are incentivized to connect with schools they may want to attend. While it is clear why schools prioritize students that make efforts to connect with them – these students are signaling that they are a good fit for the school and understand the school's academic requirements – these preferences may disadvantage lower-income, less academically-focused students that do not have the social capital or familial support necessary to navigate the process. Depending on district officials' goals, identifying the source of this missed opportunity may have important implications for the design and implementation of future school-choice systems.

Appendix A: The New York City High-School Application Process

Prior to the institution of a district-wide high-school application process in the fall of 2003, New York City's selective-enrollment schools all had their own admissions processes and students had to apply to each school separately. This system was chaotic and advantaged the students and parents who spent time tracking each school's unique application requirements and deadlines. This decentralized process resulted in a select set of 17,000 elite students being accepted to multiple selective-enrollment schools; another set of roughly 33,000 students and parents being waitlisted and forced to monitor each school's process closely for an opportunity for their children to be assigned; and left a set of roughly 30,000 parents and students assigned to schools that they did not indicate a preference for (Abdulkadiroğlu et al., 2005).

In the spring of 2003, the New York City Department of Education (NYC DOE) asked Abdulkadiroğlu and others to design a new, centralized school-matching process. Abdulkadiroğlu et al. based the new matching process on the commonly known medical-school matching process. In the new system both students and schools exerted preferences and an advanced algorithm created a stable match, one in which no unmatched student-school pair would rather be with each other than with their assignment. It is also a student-proposing process, which made it a dominant strategy for students to state their true preferences (Abdulkadiroğlu et al., 2005).

In the most simple terms, in a student's eighth-grade school year they were given a book of all their 400+ high-school options and encouraged to learn as much as they can about them by speaking with their guidance counselor, visiting a high-school fair, or attending school open houses. In the spring of their eighth-grade year, they submitted to

their guidance counselor an ordered ranking of up to twelve high schools that they would like to attend. The guidance counselors turned these lists into the NYC DOE and in turn, the NYC DOE provided all high schools with lists of the students that selected them (without being shown the student's ranking). The schools then ranked these students based on their own admissions criteria. Some schools were "selective" academically and ranked students one-by-one according to their eighth-grade academic performance. Other schools were classified as "unscreened" or "limited unscreened". NYC's Small Schools of Choice (SSCs) were "limited unscreened" schools; rather than ranking students they gave a 0/1 priority to students that made contact with them during the fall of their eighth-grade school year and/or a 0/1 priority to students that lived within the neighborhood surrounding the school⁶. After receiving each set of rankings the High School Application Processing System (HSAPS) algorithm attempted to match each student to their highest-ranked school. If there were more students that ranked a school and met its priorities then the school could serve, the algorithm used a random process to break ties between students. If a student lost the opportunity to be assigned to a given school, the algorithm then attempted to match the student to the next-most preferred school on their choice list. This process is repeated until all possible students were matched to schools on their choice list.

⁶ SSCs can classify students in up to three geographic priorities, though using two – (1) for students who either in the surrounding geographic catchment area and (0) for those who do not – is the most common.

Appendix B: New York City's Small Schools of Choice

When the NYC DOE implemented the new intra-district school-choice process it also took additional measures to improve all students' access to high-quality schools. In particular, in 2003 the NYC DOE targeted over 28 large high schools with graduation rates below 40 percent for closure and replaced them (in the same neighborhoods and sometimes the same school buildings) with new small schools. MDRC researchers Bloom et al. (2010) studied these new small schools and called them "small schools of choice" (SSCs). As of the fall of 2008 there were 123 SSCs in operation in NYC. On average, SSCs served approximately 100 students per grade and did not screen students on their prior academic achievement (unlike most other small schools in the city). Almost all of these new small schools received roughly \$400,000 in additional funds from the Bill and Melinda Gates Foundation during their first four years of operation and they strove to create curricula and school settings that focused on the Foundation's philosophy of "rigor, relevance and relationships." Recent experimental (Bloom et al., 2010) and quasi-experimental (Stiefel, 2012) evidence demonstrated that the SSCs created during this time period led to improved student academic achievement and were a high-quality education option for students living in these areas.

SSC's "School Contact" Preference

A distinguishing feature of NYC's SSCs was that, unlike other schools in the city, they did not screen students based on their prior academic achievement. Instead, NYC's SSCs ranked students according to two criteria – whether they lived in the geographic catchment area for the school and whether they made contact with the school during the fall of their eighth-grade school year. Students and parents could "make contact" with an

SSC by signing in at its high-school fair booth, attending a school open house, or calling the school to learn more about its program offerings (New York City Department of Education, 2012).

The purpose and function of SSC's geographic priority preference was clear - it ensured that students who previously would have attended the large high schools targeted for closure in the neighborhood of the new small schools received preference in the school-assignment process and had access to these new educational offerings. The theory behind SSCs' "school contact" preference, and how it affected students and parents, was less clear. The preference incentivized students and parents to connect with high schools, and while doing so, acquire information about the high-school setting and if it is the right match for them. Theoretically, this information helped students decide where they would optimize their learning and helped them create an informed choice list.

Appendix C: Data Sources and Merging Procedures

I brought together multiple New York City Department of Education (NYC DOE) data sources to trace students from their participation in the 2004-2005 high-school application process in the spring of their 8th grade year through four years of high school. The 2004-2005 HSAPS process was the second implementation year of full intra-district school-choice in NYC. I chose to focus on the second implementation year rather than the first because in 2003-2004 the admissions procedures for new SSCs were not universally advertised to parents and students and there was still some confusion (felt by both students/parents and schools) as to how HSAPS functioned.⁷ In Figure C.1 I describe each data source I use in my analysis – HSAPS, NYC DOE school records data, NYC school progress reports and Bill and Melinda Gates Foundation information - and document their structure and the years for which they were available.

My first key dataset was 2004-2005 administrative data from the New York City high-school application process. These data were available as a student-level file, with one row per student, identifying each student by their unique district id. Each student row contained a list of their first through twelfth choice and the preferences they were given by each school. There was also information about each student's eighth-grade performance on a state-mandated standardized English-Language Arts and Mathematics examination, their race, gender and free-/reduced-price lunch qualification status.

As a first step, I identified which student choices were for small schools of choice using a combination of public information on each school's admissions selectivity, start-

⁷ Specifically, both schools and students did not always receive accurate information on how the "limited unscreened" preference was exerted by Small Schools of Choice and there was conflicting information on this preference in the 2003-2004 NYC High School Directory (2004).

up year (small schools of choice fulfill the “limited unscreened admissions category” and were created between 2002 and 2008), and Bill and Melinda Gates Foundation (BMGF) administrative records (all small schools of choice received at least a small amount of start-up funds from BMGF during this time period). I deleted all students that never chose a small school of choice and excluded students that are not enrolled in NYC public high school during eighth-grade.

I then merged the HSAPS data with students' 2005-2006, 2006-2007, 2007-2008, 2008-2009 enrollment and discharge files by their unique district identifier. If a student had graduated⁸, dropped out or moved away, this was indicated on their discharge file. If there was no discharge information for them, they were still enrolled in the NYC DOE at the end of 2009.

⁸ In order to graduate from a NYC public high school a student must attain a Local, Regents or Advanced Regents diploma from New York State (NYS), attainment of all diploma types is indicated on students' NYC DOE discharge files.

Appendix D: Subsample of First-Choice Students

As a sensitivity test of whether conducting these analyses on a sample containing multiple student observations biases the findings, I addressed research questions one and two a second time, in a single-observation per student dataset for a sample of students who selected an SSC as their first choice. I present findings from this subsetted sample in *Appendix Tables D.1 and D.2*. I find that they are strikingly similar to the results from the full dataset, and hence report on the latter in the text.

Appendix E: Attrition from the Sample

Roughly 27 percent of the eighth-graders district-wide that participated in the HSAPS process in 2004-2005 did not stay in NYC public schools through four years of high school and either moved out of the district or transferred to private/parochial schools. These students cannot be included in the sample when answering the second research question, as their high school graduation data is missing.

This attrition constrains the generalizability of my findings to students that remain in New York City Public Schools through four years of high school. In an effort to understand whether the relationship between a student making contact with a school on their choice list in eighth-grade and their probability of graduating high school for years later may be different for students that left the sample I investigated whether certain types of students had a higher probability of leaving the sample than others. Specifically, in Appendix Tables E.1 and E.2 I present an analysis of the relationship between a student's characteristics (including whether or not they made contact with an SSC on their choice list) and their probability of leaving the sample. I find that that while being overage for grade in eighth-grade and qualifying for special-education services are strong predictors of whether a student will leave the sample, there is no relationship between whether a student makes contact with a SSC on their choice list and their probability of leaving the sample.

Tables

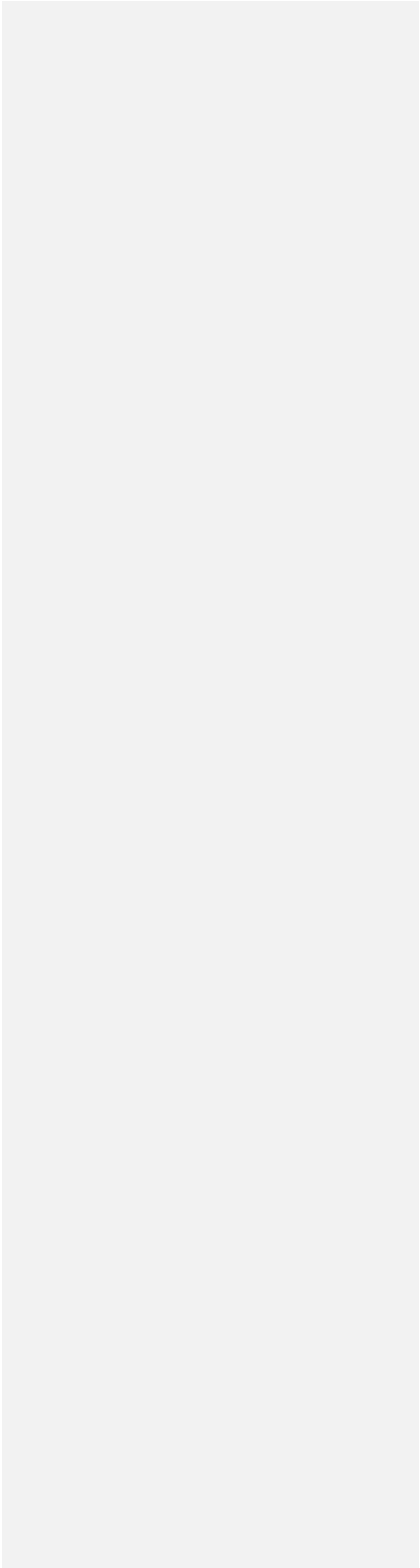


Table 1. Parameter estimates and approximate p-values for a fitted logistic regression model predicting the relationship between whether a student makes contact with a SSC school on their choice list (vs. does not make contact) and their free-/reduced-price lunch status, their eighth-grade state standardized test scores, whether they were overage for grade in eighth-grade, whether they are an English Language Learner and whether they qualify for Special Education Services, for a sample of 26,813 students.

8th grade characteristic	Model 1	Model 2	Model 3	Model 4
Intercept	0.619***	-8.390***	0.852***	-4.277***
Frlunch	-0.233***	-0.155***	-0.203***	-0.157***
PriorM		0.194***		0.184***
PriorR		0.242***		0.231***
Absent		-0.605***		-0.596***
Overage			-0.511***	-0.356***
SPED			-0.740***	-0.398***
ELL			-0.147***	0.105
R^2	0.004	0.149	0.051	0.156
-2LL	35624.190	32581.830	34601.622	32373.088
H_0			$\beta_{FRLUNCH}, \beta_{ABSENT},$ $\beta_{PriorM}, \beta_{PriorR},$ $\beta_{Overage}, \beta_{SPED}, \beta_{ELL}=0$	
Difference in -2LL			-3331.556	
df			7	
Decision			Reject H_0	
Key: * $p<0.10$, ** $p<0.05$, *** $p<0.01$				

Students' Behavior During A School-Matching Process

Table 2. Parameter estimates and approximate p-values for fitted logistic regression models predicting the relationship between a student's probability of graduating high school in four years and whether they made contact with at least one SSC school on their choice list (vs. does not make contact), their free-/reduced-price lunch status, the number of times they were absent in eighth-grade, their eighth-grade state standardized test scores, whether they were overage for grade in eighth-grade, whether they are an English Language Learner and whether they qualify for Special Education Services, for a sample of 21,400 students.

	Model 1	Model 2
Intercept	-0.022**	0.468***
Contact	0.806***	0.294***
Frlunch		-0.118***
PriorM		0.383***
PriorR		0.418***
Absent		-0.562***
Overage		-0.477***
SPED		-0.090***
ELL		0.192***
R^2	0.05	0.26
-2LL	27736.84	23890.52
H_0	$\beta_{FRLunch},$ $\beta_{PriorM},$ $\beta_{PriorR},$ $\beta_{Absent},$ $\beta_{Overage},$ $\beta_{SPED},$ $\beta_{ELL}=0$	
Difference in -2LL		3846.32
df		6
Decision		Reject H_0

Key: * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 3. Parameter estimates and approximate p-values for fitted logistic regression models predicting the relationship between a student's probability of dropping out of high school in four years and whether they made contact with at least one SSC school on their choice list (vs. does not make contact), their free-/reduced-price lunch status, the number of times they were absent in eighth-grade, their eighth-grade state standardized test scores, whether they were overage for grade in eighth-grade, whether they are an English Language Learner and whether they qualify for Special Education Services, for a sample of 26,813 students.

	Model 1	Model 2
Intercept	-1.501***	-2.058***
Contact	-0.543***	-0.128**
Frlunch		-0.052**
PriorM		-0.043**
PriorR		-0.116***
Absent		0.351***
Overage		0.911***
SPED		0.002**
ELL		0.018*
R^2	0.02	0.11
-2LL	21540.67	20012.67
H_0	$\beta_{FRLunch}, \beta_{PriorM}, \beta_{PriorR}, \beta_{Absent}, \beta_{Overage}, \beta_{SPED}, \beta_{ELL}=0$	
Difference in -2LL		1528.00
df		6
Decision		Reject H_0

Key: * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table C.1. A description of the data collected for the study (Bloom et al., 2010).

Data Source	Sample	School Years	Description of Data
New York City High School Application Processing System (NYC HSAPS)	Data were available for all eighth-grade students who completed their application to the High School Application Processing System.	2004-2005	These files contained information about the school choices and rankings made by each student, as well as a student's geographic priority and "contact" status for each school. The files also contained the program/school to which each student was assigned by the HSAPS algorithm as well as their eighth-grade demographic characteristics.
NYC DOE June enrollment data	Data were available for 6th- to 12th-graders enrolled in NYC public schools. This file contained all students who enrolled in grades 6-12 at any point during the school year.	2005-2006 to 2008-2009	The June enrollment files contained demographic and identification information for each student as of the end of the school year. These data also provided detailed information about each student's disposition at the end of the year.
NYC DOE student discharge/transactional file	Data were available for all high-school students in the New York City public school system. Data were collected throughout the school year.	2005-2006 to 2008-2009	The transactional file recorded each movement a student made into or out of a school in the DOE system. The final transaction a student made on this file was used to construct the graduation measures for this study.
Administrative records provided by the Gates Foundation and intermediaries	Data were available for all new small schools that started after the 2002-2003.	2002-2003 to 2008-2009	These school-level data contained information on whether a new small school was started with funding from the Bill & Melinda Gates Foundation.

Table D.1 Parameter estimates and approximate p -values for a logistic regression model displaying the fitted relationship between whether a student attrits from the sample and whether they make contact with an SSC, controlling for their free-/reduced-price lunch status, their 8th grade standardized state test scores, whether they were overage for grade in 8th grade, if they are an English Language Learner and if they qualify for Special Education services, for a sample of 26,813 students.

	Model 1
Intercept	-1.112***
Contact	0.051
FRLunch	-0.063
PriorM	0.001
PriorR	0.001
Overage	-0.442***
ELL	-0.042
SPED	0.641***
R^2	0.054
$-2LL$	70182.764

Key: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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